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Dynamic coupling of vegetation and hydrology greatly modifies results of classical static modeling approaches

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Prediction and simulation of the feedbacks between vegetation and hydrological processes require models that can explicitly represent the relationships between hydrology and vegetation. Most current hydrological models simulate plants without or only little dynamic features. Most current ecological models simplify hydrological conditions and ignore the dynamics of spatially distributed hydraulic conditions. In this study, we present a coupled plot-scale hydrological–vegetation model, which is composed of a fully-integrated HydroGeoSphere (HGS) model that is dynamically coupled with a highly flexible vegetation model (PLANTHeR). By comparing the results between a coupled and a non-coupled model over 1000 years, we found that the dynamic simulation of plants homogenized the soil water gradient that was initially generated by topographic slope, while the static implementation of plants did not lead to obvious changes of the soil water stress gradient. Vice-versa, spatio-temporally heterogeneous dynamic soil water potential resulted in a higher plant diversity and plant functional types (PFTs) richness than when simulated with homogenous static soil water potential. In summary, the hydrologic conditions and the plant community structure differed meaningfully when the two dynamic models were coupled. Therefore, we advocate the application of dynamic coupling of vegetation and hydrological models instead of modeling these two compartments in isolation.